

K2 Proposal on behalf of KASC WG3

# Asteroseismology of roAp and Ap stars

Prepared by Peter De Cat, Gerald Handler, Luis Balona & Victoria Antoci

---

The chemical peculiarity in Ap stars is a result of the interplay between gravitational settling and radiative acceleration in the presence of a strong magnetic field which leads to the upwards diffusion of metals. A subset of the Ap stars, the rapidly-oscillating (roAp) stars, pulsate in multiple periods in the range 5–20 min. The current idea is that pulsational instability is a result of the  $\kappa$  mechanism in the hydrogen ionization zone. Convection is stabilized around the magnetic poles owing to the kilogauss field strength, allowing pulsational driving to overcome the damping. Unfortunately, the predicted instability strip does not match the observed instability strip (Cuhna, 2002MNRAS.333...47C; Theado et al., 2009A&A...493..159T). Furthermore, the pulsational periods in many roAp stars are shorter than the critical cut-off periods (Saio, 2013arXiv1309.7251S).

Observations of roAp stars from the *Kepler* space telescope has changed our perspective of roAp stars quite significantly. There are three well-studied roAp stars in the *Kepler* field. Perhaps the greatest surprise was the discovery of a low-frequency variation in KIC 8677585 (Balona et al., 2011MNRAS.410..517B) which appears to be linked to the high-frequency roAp pulsations (Balona et al., 2013MNRAS.432.2808B). In two other roAp stars a period of about twice the rotation period is present (Balona, 2013MNRAS.436.1415B). In another roAp star, there seems to be two different pulsation axes (Kurtz et al., 2011MNRAS.414.2550K). These discoveries are unexpected and unexplained and strongly suggest that our current understanding is inadequate.

HD 258048 (Holdsworth et al., 2014arXiv1401.3199H) is the only confirmed roAp star in Field 0, which is the first star on the attached list `WG3_roAp_Field00.csv`. There are 100 known Ap stars within a  $12^\circ$  radius of the centre of Field-0. Since roAp stars are found amongst the coolest Ap stars, the attached list has been sorted so that the coolest stars are on top of the list and the hottest at the bottom. We propose that as many of these stars as possible be observed in short-cadence mode. This is a unique opportunity to determine the limits of the instability strip of roAp stars, eliminating the observational bias which probably exists in ground-based observations.

It is important to know what fraction of Ap stars are  $\delta$  Sct pulsators. The expectation has been that helium is partly drained from the driving region and that the fraction of Ap stars which are  $\delta$  Sct stars should be small. We realize that SC slots are in high demand, so in the attached table, stars have been ordered according to perceived priority. We recommend that as many of these stars be observed in short cadence mode, but failing this, it would be important that long-cadence observations be made of all Ap stars to determine the fraction which are  $\delta$  Sct pulsators and also to determine their rotational periods from the light variations.